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FIRES IN SURFACE MINING AND MILLING STRUCTURES

BY

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UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

FIRES IN SURFACE MINING AND MILLING STRUCTURES [1]

By D. Harrington [2] and J. H. East, Jr. [3]

Fire is always a serious menace, whether in a residential or in an industrial region; in wartime it is particularly damaging in an industrial plant. The mining industry is especially vulnerable, as its plants are generally more or less isolated from centers of population and do not have access to modern fire-fighting equipment; moreover, owing to the transitory nature of most mines, their surface structures are often relatively flimsy and flammable. Trained firemen seldom are available at or near mining plants to teach the fundamentals of fire-fighting to local fire brigades, with the result that efficiency in combating actual fires is lacking. Often the attitude "it can't happen here" is held by the management of a mining property, unless the plant has suffered a serious fire; even then lapse of time is very likely to induce forgetfulness as to the possible hazards.

The necessity for producing metals for the prosecution of this war has increased management's responsibility. Whereas heretofore the loss of a plant or mill by fire meant merely monetary loss to the stockholders of the company, now the national interest is affected, in that the nation suffers from loss of production of minerals indispensable for war purposes.

Fire is a highly effective weapon of the saboteur; hence, not only must the usual fire hazards be guarded against that may cause loss of life or property, but it has also become necessary to prevent the setting of fires by deliberate intent to stop or reduce production.

Occurrence of fires can be reduced to a minimum by simple, sensible methods that have been practiced for years in manufacturing plants in many urban areas as well as in progressive mining plants, hence cannot be classed as experimental or theoretical. Years of experience testify to their soundness.

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The basic principles of prevention of fires or excessive damage from them are good construction, safe operation, adequate protective systems, and organization for emergencies.

Many fires get their start and become destructive for lack of such simple, obvious things as:

1. "Good housekeeping."
2. Fire-resistant storage facilities for flammable materials.
3. "First-aid" fire-fighting equipment.
4. Adequate water supply and distributing system.
5. Well-organized and properly trained employee fire brigade.
6. Fireproof barriers in wooden buildings to localize fires.
7. Precautions during cutting and welding operations.
8. Properly installed electric wiring.
9. Care in the use of highly volatile inflammable liquids, such as gasoline, for cleaning purposes.
10. Properly insulated heating stoves.

Good housekeeping includes, in addition to the general definition of the word as used in industry, the disposal of paper; disposal of oily waste and rags in metallic, self-closing containers; removal of accumulated chips, sawdust, and shavings or other readily combustible materials; the sealing of spaces between building floors and ground; and many other things frequently overlooked. The segregation of flammable or combustible materials, and the piling of materials to allow suitable aisle space is all a part of good housekeeping.

Fire-resistant storage facilities for flammable oils, greases, paints, kerosene, and fuel oil are necessary at any mining plant where storage is near other buildings or where loss of the materials would impede production. Such buildings should have concrete or gravel floors, with good ventilation for both roof and floor; they should also be provided with vaporproof electric lighting fixtures. Drip pans under spigots and buried gasoline and fuel-oil storage tanks are all to be considered carefully. Storage facilities that cannot be made safe should be isolated so that fire will not endanger other parts of the plant.

Enough regularly serviced fire extinguishers of a type suited to the work should be placed in strategic places throughout the plant; they should always be readily accessible and plainly marked. Sand, rock dust, or other inert material is of great assistance in handling some types of fires and should be kept handy in boxes.

Seldom is an adequate water supply found at mining plants, and often the distributing system is poorly laid out. Fire hydrants should be placed

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at such a distance from a building that a fire would not prevent their use. A standard fire stream is generally recognized as 250 gallons per minute with a 1-1/8-inch nozzle and a pressure of 45 pounds at the nozzle, and at least two fire streams should be available in an emergency. The friction loss of water flowing in pipes is higher than is generally realized; with a flow of 500 gallons per minute, the friction loss per 1000 feet in a 6-inch pipe is 15 pounds per square inch, and in 4-inch pipe it is 100 pounds. 4/ Connecting fire mains to form a loop to eliminate dead ends is always recommended.

To be efficient, employee fire brigades must receive training at regular intervals. All members should be trained in the operation of all types of fire-fighting equipment on the property; they should be instructed how to operate fire pumps if the plant is equipped with pumps; the location and operation of water valves should be made known to them; and they should know how and where to cut off the electric power. They should be instructed as to the type of fire-fighting equipment best suited for use in various types of fires.

Many mining plants have groups of wooden buildings connected with wooden snowsheds. Fireproof or fire-resistant barriers should be part of the construction to localize a fire. Large mill buildings should have some fireproof partitions to prevent rapid spreading of a fire and to give the fire brigade additional time to extinguish the blaze.

Cutting and welding with oxyacetylene torches is a prolific cause of fires, both on the surface and underground. The place of work should be thoroughly wet down before the torch is used and again after the work has been completed. A fire extinguisher should be part of any portable welding outfit. Good practice requires a second fire inspection at least 1 hour after welding or cutting has ceased; this is becoming one of the most essential features in prevention of fires in and around mining plants.

Electric wiring should be done in accordance with the requirements of the National Electrical Code. Wiring that will not meet the requirements of the code should be inspected frequently and carefully, as poor electrical wiring is another common cause of fires.

The use of high flash point or noninflammable liquids for cleaning machinery should be required; gasoline has caused so many fires as well as accidents that its use for this purpose should be prohibited. Virtually all major oil companies manufacture a petroleum product suitable for this purpose classed as Stoddard Solvents and sold under a variety of trade names. These have solvent properties approximating gasoline, but with fire-hazard properties similar to kerosene. Trisodium phosphate also is recommended for cleaning.

4/ National Board of Fire Underwriters Fire Stream Tables.

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Heating stoves should not be installed near wooden walls without suitable insulation nor placed directly on wood floors without an incombustible lining such as hollow tile, steel plate covered with asbestos sheet lining, or a sand tray. Roof fires in surface buildings caused by overheated stove pipes and poorly constructed chimneys are reported frequently.

Much has been written about fire prevention, and definite standards have been set by the National Fire Protection Association, which, with some modifications, will cover almost any mining installation. These standards can be obtained from the association or from many public libraries. The National Park Service, Department of the Interior, has issued a publication entitled "Prevention and Control of Fire Losses," which contains much information on fire prevention.

SOME EXAMPLES OF RECENT FIRES IN MINING PLANTS

West Virginia Mine

Fire destroyed the power plant at a West Virginia coal mine in May 1943, with an estimated loss of $25,000. The mine will be idle until the power plant is rebuilt - possibly 6 months, as priorities for needed materials are difficult to obtain. The mine employs 190 men, and the average daily production is 750 tons; hence, this fire may cause loss of production of upwards of 100,000 tons of coal at a time when coal is sorely needed.

The sides and roof of the power-plant building were of wood-frame construction covered with corrugated sheet metal. The floor was of tongue-and-groove lumber. One 3-gallon foamite fire extinguisher was in the building, and running water was nearby, but fire buckets had not been provided.

Two barrels of oil, one barrel of grease, one barrel of kerosene, and four gallons of gasoline were stored in the building. The floor of the building was soaked with oil from leakage from three Diesel engines. Mechanics were cleaning and inspecting equipment and were using gasoline from a 2-gallon can for cleaning purposes. The power plant was on a hillside, and the space between ground and floor was used for storage. The ground beneath the floor was fairly well soaked with oil, and oily waste had been thrown there.

The cause of the fire is not known, but it probably started at the gasoline container used by the mechanics. One of the men removed the container from the building while the other smothered the flames with seat covers from an automobile. Fire was discovered burning under the floor, and the men attempted to extinguish it with the fire extinguisher and with water, but the fire was beyond control. Although the mechanics stated they had not been smoking, smoking is suspected as the probable ignition agency.

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Oklahoma Mill

Fire was discovered in an Oklahoma zinc ore-concentrating mill in March 1943 by a company official who was passing the plant. A night watchman coming on shift reached the plant at the same time. The fire department was called and reponded in a few minutes, but the fire had made such headway that only adjacent buildings were saved. All machinery in the mill building was either damaged or destroyed by the fire. Neither the watchman nor the company official knew how to start the fire pump, and part of the company-owned fire hose was found to contain ice, which caused the hose to rupture when the water was turned into it.

Repair crews finished work at 3:30 p.m. (Sunday), but no one had been in the end of the mill where the fire started later than 3 p.m. Numerous wooden catwalks are in this section, and many were covered with grease and oil. The repairmen had been using acetylene torches during the day, and smoking had been permitted. The electric power had not been cut off the mill building when the repair crew left the mill. Electric switches were on wooden panel boards, and motors were on wooden platforms. Some of the wires were not in conduit.

The cause of the fire has not been determined. Destruction of the mill is a serious blow to the production of zinc at a time when zinc is needed for war purposes.

Colorado Mine

A fire broke out in the blacksmith shop of a Colorado mine in January 1942 and spread to adjacent buildings, all at the portal of the main haulage tunnel. Smoke from the fire filled the mine, and eight miners were suffocated.

Log cribbing 10 to 15 feet high was built around the tunnel portal to support the sides of a steep cut. The compressor house and blacksmith shop were built into this cribbing, one at the right of the tunnel portal and the other at the left; both were of wood construction connected by a wood-roofed snow shed over the portal and extending about 100 feet to the ore chute dump.

The compressor building housed two compressors, machine lathe, work bench, and a small transformer. At the time of the fire, 50-gallon drums of compressor oil, cylinder oil, and cutting oil were stored in the building as well as a supply of oxygen and acetylene gas. The blacksmith shop housed a low-pressure oil forge, two compressed-air-operated drill sharpeners, an electric grinder, and a blacksmith forge. The 110-volt electric wiring was on insulators but not in conduit. A 10-gallon drum of distillate fuel for the oil forge was on the roof of the shop so that the oil might be fed by gravity to the forge through a 3/8-inch pipe line fitted with a shut-off valve, which

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supplemented the regular feeder valves. An open coal bin was on the west side of the blacksmith shop, and nearby were two 50-gallon drums of distillate. Both coal and oil were near the tunnel portal. An old wood mill building was about 50 feet in front of the portal and was used only as a stable and timber shed. Several bales of hay were piled outside the part used as a stable. A two-story boarding house was 140 feet from the mine portal. This building was menaced by the fire but was not burned. Fire-fighting equipment consisted of a few 1-quart carbon tetrachloride-type fire extinguishers distributed in the various buildings.

The general superintendent came out of the mine at about 11.25 a.m. and went to the boarding house. The blacksmith shut off the oil forge at the same time and instructed his helper to watch it, then he also went to the boarding house. The fire alarm was given before he started to eat

Two other men started to eat lunch in the compressor house, when they noticed smoke and immediately stopped the compressor. They attempted to enter the blacksmith shop but were stopped by the flames. The fire spread rapidly to the compressor house and mill but stopped when these buildings were burned. The fire was fought ineffectively by shoveling snow on it and by using the few available fire extinguishers.

The cause of the fire was undetermined. It may have been caused by a short circuit in the electrical wiring or a leak in the oil-forge supply line through which oil was sprayed on to the hot forge.

Oklahoma Zinc Mill

A fire was discovered by the night watchman in an Oklahoma zinc mill about 5 a.m. in February 1943. The structure comprised the shaft house, ore bins, crushing plant, concentration plant, compressor room, and storeroom. The mill operated from 8 a.m. until midnight and had a rated capacity of 750 to 1,000 tons of ore in 24 hours .

The night watchman made regular trips through the mill punching the key stations hourly. His duties included keeping fires in a number of coal stoves throughout the plant. The watchman stated he had placed coal in a number of stoves and laid the clock down near an electric switch while he went upstairs to cover a motor on account of a rain. While he was upstairs he heard a loud noise below and ran down to investigate. He saw the electric switch and surrounding area in flames. He roused the mill master mechanic, who lived about 100 yards away, and called the fire department, which responded in 5 or 6 minutes . Several barrels of oil and flotation reagents were stored in the mill about 10 feet from the place where the fire started.

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The master mechanic stated trouble had been experienced with the electric switch responsible for the fire, which had caused the wooden terminal supports to burn. The "smoking and sputtering" at the switch had given warning of trouble, and the wooden terminal supports were replaced. The switch box held about 10 gallons of transformer oil.

The chief of the fire department stated he arrived at the mill within 6 minutes after receiving the fire alarm, and that the whole mill structure was in flames. He stated many explosions occurred in the burning building after his arrival. The transformer building and other surrounding structures were all that could be saved.

The proprietor of an electrical company that had done much of the electrical work at the mill confirmed the statement of the master mechanic that the wooden terminal supports had been changed several times because the wood had been burned, and stated an unsuccessful attempt had been made to obtain a porcelain-insulated support. He said the main switch in the transformer house should have been pulled when the mill was not in operation, but that he did not believe the switch would have "exploded without warning," as stated by the watchman, and was of the opinion that the progress of the fire indicated it might have been burning for some time before the watchman saw it.

The fire probably was started by an electric arc in the starting compensator (called electric switch above); combustible fuel was present at the starting point, which contributed to the rapid progress of the fire. Failure to pull the main switch at the transformers when the mill was closed down probably was the direct cause of the fire. Failure to pull the switch when only one watchman was on duty and a switch known to be defective contributed to the rapid progress the fire was able to make when once started.

South Dakota Mine

Fire was discovered in the concentrate dryer room in a South Dakota mill at about 11 a.m. in January 1943. The mill and Diesel plants were housed in the same building, which was constructed of wood and covered with galvanized-iron sheeting. The concentrate dryer was a 5 by 40-foot indirect-heating rotary type. The compressed-air oil burner was placed outside the combustion chamber, so that the flame entered the chamber and supplied heat to the closed dryer pipe.

The general superintendent stated that the burner flared frequently and had to be cleaned often. The burner was specified to work efficiently with 15°-gravity heavy black oil, but owing to difficulties in obtaining this grade a mixture of lighter fuels was used, which gave an oil with a relatively low flash point.

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The general superintendent stated he was in the mill and the oil burner was working normally a few minutes before the fire. He had gone to the Diesel engine room when he was notified of the fire. A fire hose was connected immediately, but the fire had gained such headway that fire fighting was ineffective. The mill and Diesel plants and equipment were burned completely in less than 1 hour.

The burner was situated 6 feet below a wooden floor, 5 feet from one wooden wall, 9 feet from another wooden wall, and 5 feet from a concrete wall. The floor was concrete. The burner is believed to have clogged and flared as it had in the past and to have ignited the surrounding woodwork.

This is an example of apparent failure to correct a fire hazard known to exist. The mill product was a war essential and its loss is a serious blow.

New Jersey Mine

Fire was discovered by the foreman in a New Jersey iron-ore mill about 5:10 p.m. in June 1943. The foreman smelled smoke while he was on the top floor starting the flow of damp ore to the dryer. He ran to the lower floor and saw a wooden chute burning beneath a screen that receives the hot ore as it passes from the dryer. Two men on the top floor were called to help extinguish the blaze with carbon tetrachloride-type fire extinguishers but they were unsuccessful. After about 10 minutes the men opened the water valve on the "dry pipe sprinkler system" and, with four other men, obtained a fire hose from a shed near the plant road. One man turned in the fire alarm, and fire departments from several nearby towns responded; but the fire had made such headway that the roof collapsed, breaking the sprinkler pipes, which caused a drop in water pressure. The building was of wood construction and burned rapidly, nearly the entire upper part of the mill structure being consumed.

The cause of the fire is unknown. The most logical explanation is that some of the hot ore discharged from the dryer after passing through the receiving screen lodged on the wooden chute below, setting fire to it. The ore feed was unusually damp that day, requiring that the dryer be operated at full capacity to dry the ore satisfactorily.

The use of wood in the construction of chutes or bins in handling or storing of hot materials is anything but good practice; fireproof materials should have been used.

The need of training for employee fire brigades is demonstrated. The employees should have called the fire department when the fire was first discovered and should have applied water to the fire. Properly installed

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sprinkler systems are usually more effective in fire fighting than chemical fire extinguishers, though in this instance the sprinkler system evidently was not effective.

It is more important now than ever before in the history of mining in the United States to prevent loss of essential materials and plants, not only because they are essential but also because of the difficulty of replacing them.

Fire hazards usually can be eliminated at small expenditure of labor and money as compared with the amount of loss likely to result from a fire. Careful survey by a competent fire-prevention engineer of conditions and practices at each plant and correction of those not standard will reduce most fire hazards. Fires in surface plants producing minerals essential to the prosecution of the war constitute definite sabotage at this time, whether the fire is caused maliciously or through carelessness. Beware of Fires in Mineral Plants.

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